Four-coach multiple-unit train for a maximum speed of 105 km/h (65 m.p.h.) supplied to the Swedish State Railways. (F 542)

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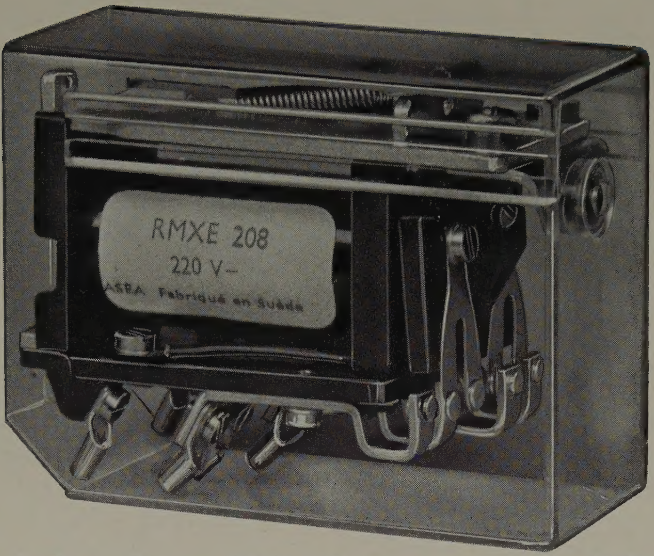
4

INDUSTRIAL RELAYS

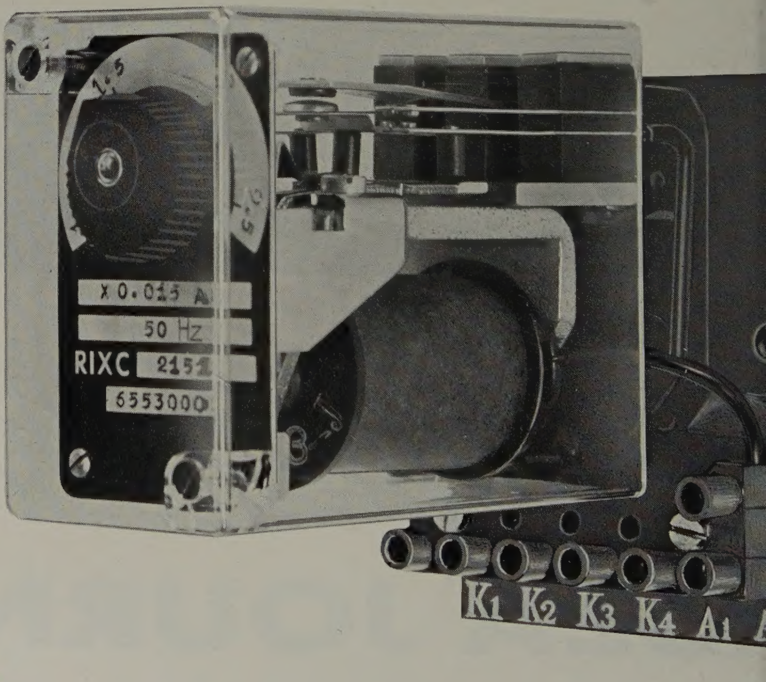


(55347)

Auxiliary relay type RMXE with two robust contacts which can be turned for either making or breaking. It is also available with two make and two break contacts.

Relays for process control in industry and for use in vehicles are often subject to shocks and vibrations. We present here two simple and robust ASEA relays that can withstand such stresses. The relays of the design shown here are intended for setting up in a reasonably dust-protected place, for example, in a control-gear cubicle. They are also available with a case for external mounting or in a plug-in design.

Both types are manufactured for d.c. as well as a.c. and are tested at 2,000 V, 50 c/s.



Over-current relay type RIXC with current scale has two or three contacts, one of which has a high current carrying capacity. It operates with great speed and precision. This relay is also available in an over-voltage design.

ASEA

XPERIMENTAL LOCOMOTIVE WITH SILICON ECTIFIER CELLS

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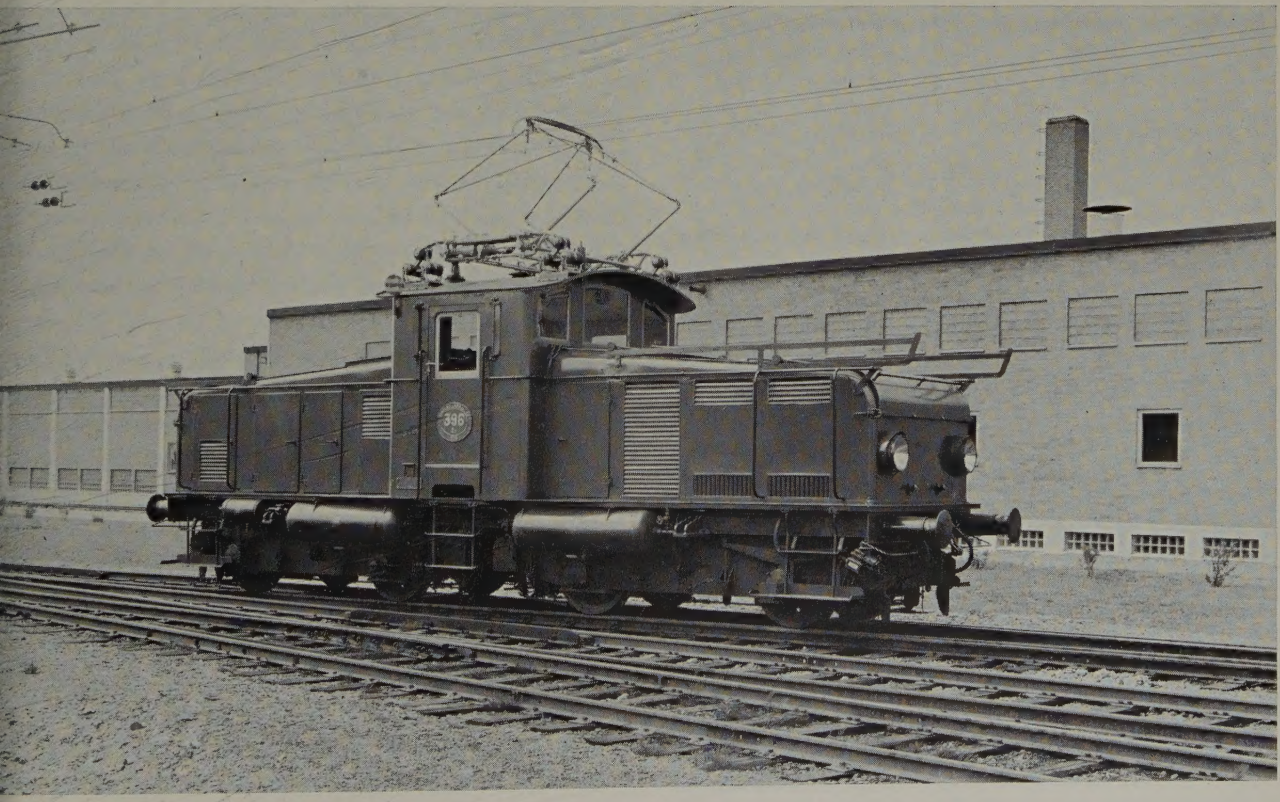
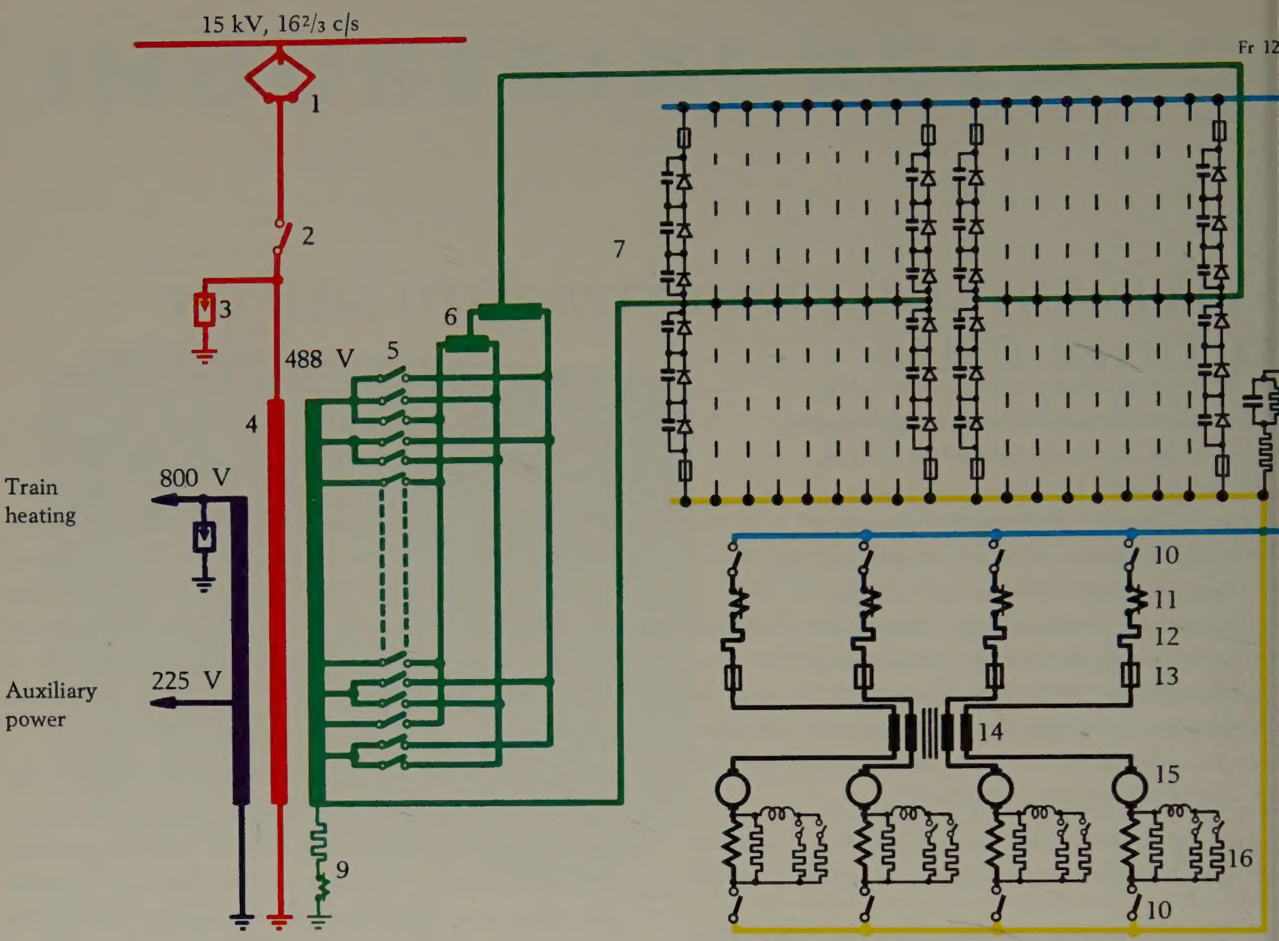
U.D.C. 621.335.2
621.314.63
Asea Reg. 6134

he article describes the electrical equipment in an experimental locomotive with a one-hour rating of 625 .p. and a maximum speed of 75 km/h (47 m.p.h.), hich Asea have fitted with silicon rectifiers. Particular ttention is paid to the voltage regulation, rectifier, pro- ective equipment, fault-indicating equipment and the quipment for smoothing the motor current. The loco- otive has been in service since January, 1960 and has iven a very satisfactory performance.

n countries in which the electric railways make use f 50 c/s alternating current, most of the locomotives are provided with rectifiers for converting the alternating current from the contact line to direct current which is then fed to the traction motors. Comprehensive tests with semi-conductor rectifiers have been carried out in a number of countries with this application in view, and some deliveries have been made to certain railways.

In order to study the special problems associated with silicon rectifiers in railway service, and the problems arising in conjunction with the feeding of traction motors with direct current having a variable degree of smoothing, Asea have adapted an old accumulator locomotive of type Öc, which the Swedish State Railways placed at their disposal. The locomotive, the appearance of which can be seen from Fig. 1, is a bogie locomotive


ig. 1. The experimental locomotive (previously an accumu- tor locomotive of type Öc) with a one-hour rating of 625 .p. and a maximum speed of 75 km/h (47 m.p.h.), which as been provided with silicon rectifiers by Asea. (55384)



1 Pantograph
2 Main circuit-breaker
3 Lightning arrester
4 Main transformer
5 Contactor starter
6 Trifurcating transformer
7 Silicon rectifier
8 Over-voltage protection
9 Earth-fault protection
10 Motor contactors
11 Over-current relay
12 Measuring shunt
13 Motor fuses
14 Smoothing reactor
15 Traction motor
16 Shunt circuit for the series winding of the traction motor

Fig. 2. The principle of the main circuits in the rectifier locomotive.

with four axles, all of which are individually driven. The installed motor rating is 625 h.p. and the maximum speed 75 km/h (47 m.p.h.). The accumulator battery, which took up the entire space under the one bonnet, was removed and the locomotive was provided with virtually new electrical equipment, except for the traction motors and the high-voltage equipment.

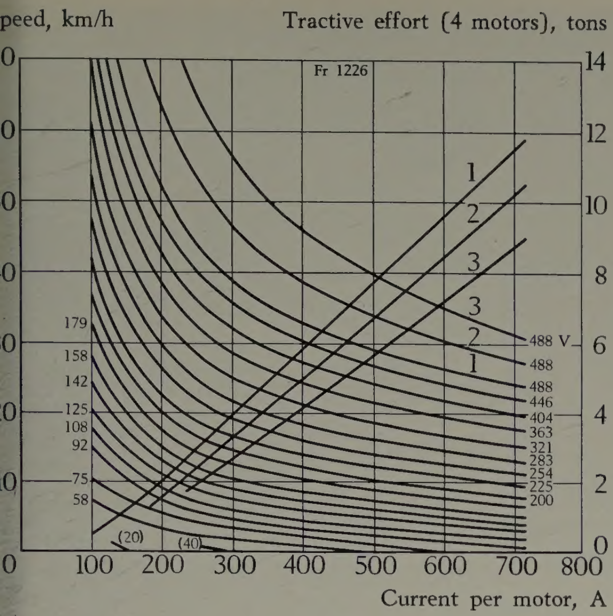
Fig. 2 shows the principle of the main circuits and Fig. 3 the characteristic curves for the locomotive.

VOLTAGE REGULATION

A characteristic feature of rectifier locomotives is that the voltage drops in the motor circuits are small. This is because there are no starting resistors connected in series as in straight d.c. locomotives and no react voltage drop in the motors as in a.c. locomotives w single-phase series motors. This means that the curre speed curves of the motors have a very slight gradie at high currents (see Fig. 3), that is to say, a sm increase in the speed brings about a considerable duction in the current and consequently in the mo torque. This is a valuable property with reference the risk of slip, but, as far as regulation is concern it means that the voltage steps must be small in or to avoid variations in tractive effort when notching on starting.

The possibility of using a transductor either alone or combination with a few voltage tappings on the tra former was investigated, but it proved that the wei and expense of the transductor with its auxiliary equ ment could not be justified on the basis of smoot control. Therefore, in the case of larger locomotiv the already well-tried high-voltage regulation syst which allows of a large number of voltage steps is be preferred.

In the case of this small test locomotive, relatively c ventional low-voltage regulation, with contactors trifurcation of the current, was selected. There twenty voltage steps, arranged by means of twe tappings on the transformer and twenty contactors.



Full field (85 per cent excitation current)
Weak field I (65 per cent excitation current)
Weak field II (50 per cent excitation current)

ig. 3. Characteristic curves for the motors of the rectifier ocomotive showing speed and tractive effort as functions f the motor current.

HE RECTIFIER

he rectifier consists of 108 General Electric silicon ells of type 6 RW 22 K [see Asea Journal 33(1960):9, p. 147–151], in a single-phase bridge connection with ine parallel chains in each branch and with three cells onnected in series in each chain. Each silicon cell is onnected in parallel with a voltage-dividing capacitor. fuse is connected in series with each chain of three ilicon cells.

he mechanical parts of the rectifier are designed in such way that the cells and fuses are readily accessible for easuring purposes. The rectifier is air-cooled and the ells are screwed into flanged cooling devices mounted oncentrically between two bakelite discs, in the centre f which there is a fan wheel of centrifugal type. After he cooling air has passed the cooling devices of the ectifier cells, it is conducted by a sheet-steel drum past he fan motor and, after the pressure has been further ncreased by means of a propeller-type fan driven by he same motor, it passes a gilled-tube radiator for the ransformer oil. Fig. 4 shows the rectifier mounted in he locomotive.

or major inspections of the rectifier unit, the latter an be withdrawn from the rest of the set and rolled ut on special wheels and rails through a double door the side of the locomotive. Fig. 5 shows the rectifier the half-withdrawn position. The fuses are directly astened to the terminal bars in the outermost ring. hrough the hole in the centre, which is normally filled by the fan wheel, it is possible to catch a glimpse of the cooling devices and, behind these, the capacitors.

The rectifier is designed for a maximum output current of 2,880 A, d.c. mean value, which corresponds to the maximum starting current of the traction motors. The maximum secondary voltage of the transformer under no-load at the nominal line voltage is 488 V, r.m.s. value.

Because of the frequent load variations in traction service, special attention had to be devoted to thermal fatigue in the silicon cells, above all, in the soldered connection between the silicon crystal and the fixing bolt. By connecting more silicon cells in parallel than would be required in a continuously loaded rectifier, the temperature rise of the crystals can be limited to an optimum value with reference to the life of the cells. One of the objects of the test locomotive is to create a firm basis for calculations of this kind.

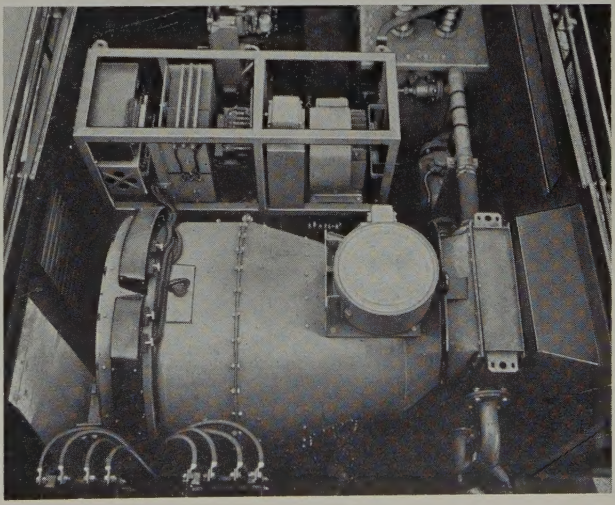
PROTECTIVE EQUIPMENT

The silicon cells require extremely rapid and effective protection against both over-voltages and over-currents.

As far as over-voltages are concerned, the locomotive is provided with lightning arresters both on the high-voltage winding of the transformer and on the separate winding for the train-heating current and auxiliary power. In addition, a large capacitor is connected to the d.c. terminals of the rectifier.

The object of the over-current protection is both to protect the rectifier against internal short-circuits caused by breakdowns in a rectifier chain, and to protect it against external over-loading and short-circuits.

Fig. 4. The rectifier set mounted in the locomotive. The cooling air is drawn in at the left and blown by fans past the cooling devices of the silicon cells and then out into the open air through the gilled-tube radiator for the transformer oil, shown at the right. (55387)



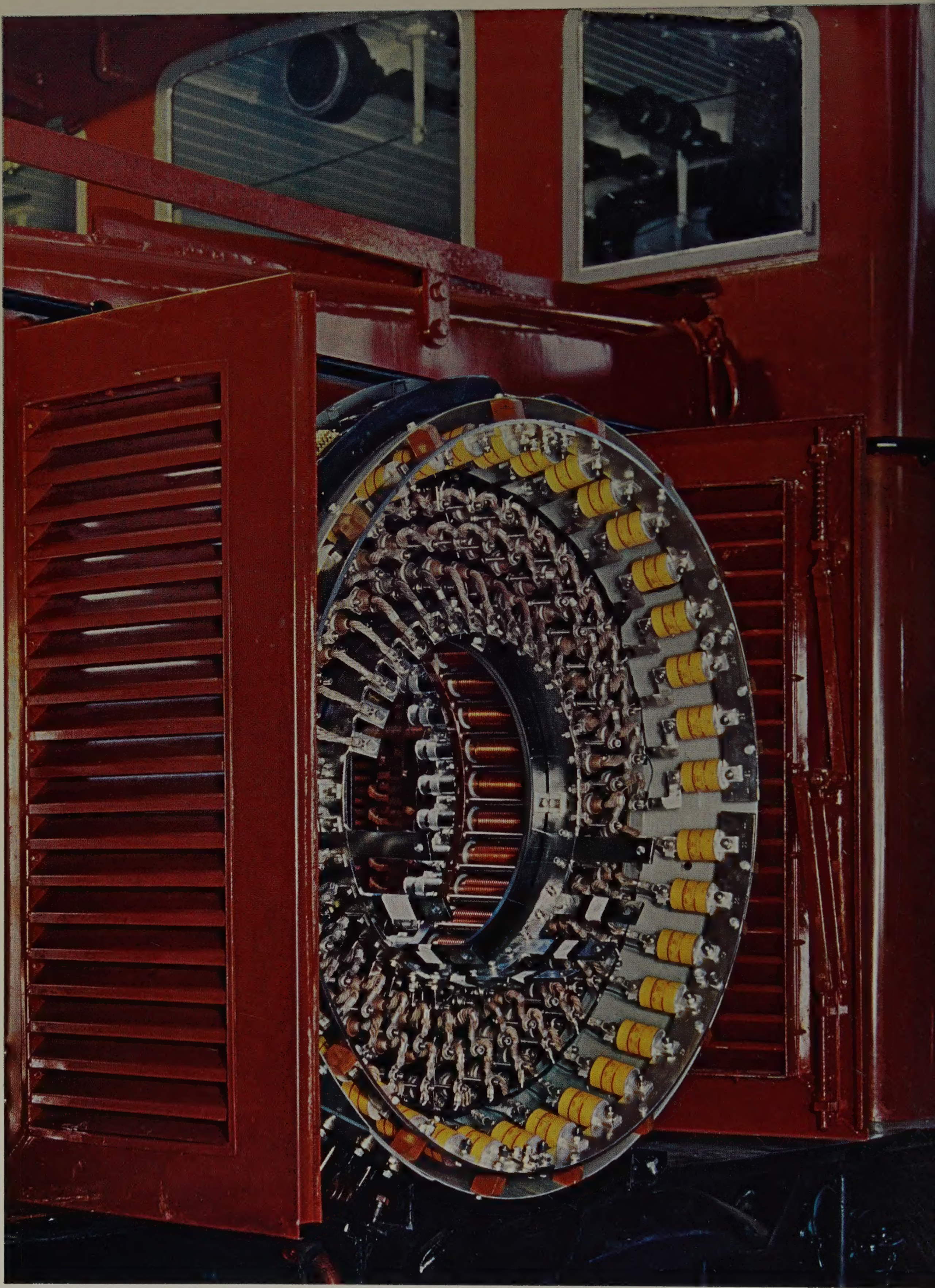
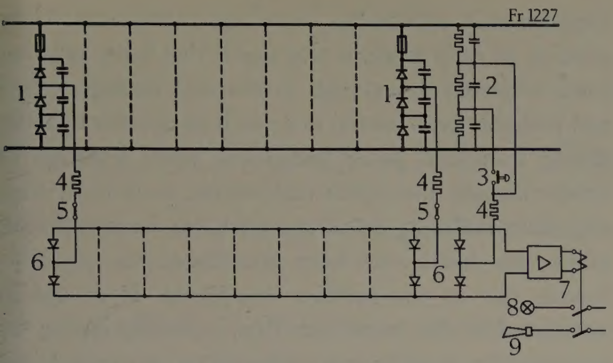


Fig. 5. The rectifier part halfway withdrawn. In the outermost ring, the fuses are directly fastened to the terminal bars. The cooling devices can be seen through the central hole and, behind these, the capacitors. (F 657)



1 Rectifier chain in the silicon rectifier
2 Reference chain for testing
3 Pushbutton for testing
4 Current-limiting resistor
5 Cancelling switch
6 Blocking rectifiers for fault current
7 Transistor amplifier with relay output
8 Signal lamp
9 Siren in the driver's cab

Fig. 6. Elementary diagram of the indicating equipment in each of the four rectifier branches.

A quick-acting fuse with a rated current of 200 A is connected in series with the three silicon cells in each rectifier chain as a protection against internal short-circuits. If a chain should cease blocking, the entire short-circuit current would pass through it and then divide itself up over the nine intact chains in the rectifier branch which was the conducting one at that moment. This means that the selectivity as between the fuses is very good and only the fuse in the faulty chain breaks the short circuit.

In the case of a minor overload, for example, careless notching up during starting, the rectifier is protected by the normal over-current relays in the traction-motor circuit. In the case of an external short-circuit, for example, flashover in a traction motor, this protection is, however, not rapid enough, and in order not to have to replace the large number of fuses in the rectifier after such an occurrence, a 600 A fuse is connected in series with each motor. This latter fuse blows before the others, without fail.

FAULT-INDICATING EQUIPMENT

In order to provide continuous information as to whether a rectifier cell has ceased to function or whether a fuse in the rectifier has blown, the locomotive is provided with special indicating equipment. This is divided up into four equal groups, one for each branch of the rectifier.

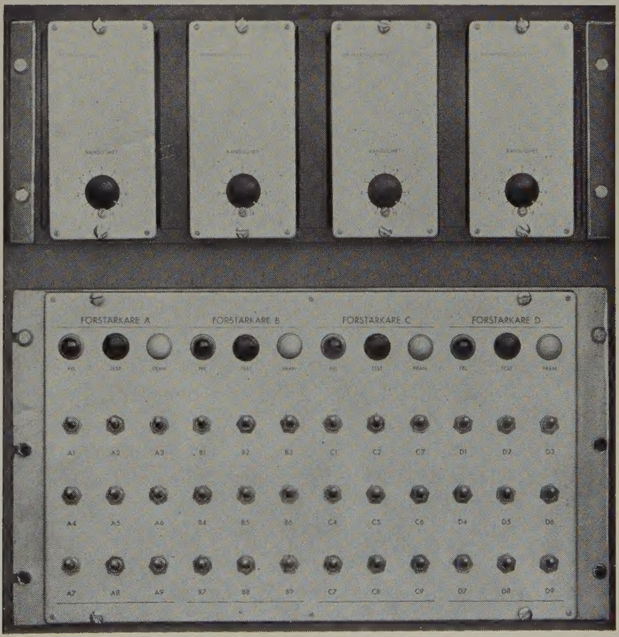
In each group, the voltage is taken between two similarly placed cells in each of the nine chains and supplied to a rectifier as shown in Fig. 6. In the case of a difference in voltage between one chain and the others, a differential current is fed into an amplifier, the output stage of which is connected to a relay. This latter switches on a siren in the driver's cab and a lamp lights up on a signal board which indicates the rectifier branch in which the fault is located. The faulty rectifier chain can be localised and the fault signal from it cancelled by means of a number of switches on the signal board. In addition, for testing the equipment, there is a tenth chain in each rectifier branch which consists of resistors and capacitors and can be brought into a state of unbalance with the aid of a pushbutton on the signal board. Fig. 7 shows the four amplifiers, which, for reasons of insulation, must be mounted in a bakelite frame, and, under these, the signal board.

The reason why the fault-indicating equipment has been made so relatively comprehensive is mainly that the locomotive is being used for tests and experiments and it does not imply that, in normal service, any high fault frequency is expected. Since the rectifier has been designed on a generous scale, it is not necessary to take the locomotive out of service if individual rectifier faults arise.

EQUIPMENT FOR SMOOTHING THE MOTOR CURRENT

The pulsations in the direct current cause commutation difficulties and considerable heating of the traction motors. In order to counteract this, a resistive shunt has been connected in across the series winding and a smoothing reactor has been connected in series with

Fig. 7. The four transistor amplifiers for the indicating equipment and the signal board. (55386)



each motor. The resistive shunt is so selected that about 15 per cent of the direct current goes through it, but, because of the inductance in the field winding, a considerably larger percentage of the ripples will pass through the shunt. The inductance of the smoothing reactor is so selected that the ripple at the rated current of the traction motors is about 30 per cent. The smoothing reactor is air-cooled and is so designed mechanically that minor adjustments of the air-gap in the field circuit can be carried out.

THE TESTS AND EXPERIENCE IN SERVICE

The locomotive was taken into service in January, 1960 and used by the Swedish State Railways both for shunting and for main-line service. In order to facilitate inspections of the locomotive by Asea, and the arranging of the more comprehensive test runs, it is at present based in the Västerås area.

The tests planned and carried out hitherto have been concerned with the commutation conditions of the rectifier, the ripples in the direct current and the harmonics and the power factor on the alternating-current side. Comprehensive measurements have also been made to check the distribution of current and voltage between the cells of the rectifier. Measurements of the ripples in the current and the magnetic flux in the various windings of the traction motors have also been carried out.

Experience in service has been very satisfactory. Hov
ever, at an early stage, it was found that some cells ha
been subjected to external mechanical damage, whic
had probably been caused as a result of careless handlir
during transport. After these cells were replaced, n
similar damage has arisen and neither have there bee
any other faults in the silicon cells, nor have any fus
blown, nor has service been interrupted for any othe
reasons due to the rectifier equipment. It should b
mentioned in this connection that, especially during th
test runs, the rectifier was subjected to very great load
up to the limit of what the rest of the traction equip
ment would withstand.

During the autumn of 1960, a number of the Gener
Electric silicon cells hitherto used were temporarily r
placed by cells manufactured by Asea, in order to g
these tested in traction service in advance of the larg
scale application mentioned below.

The experience gained with this locomotive will, in th
first place, be applied to two four-axle bogie locomotiv
with a motor rating of 4,500 h.p. and a maximum spee
of 120 km/h (75 m.p.h.), which are to be provided wit
d.c. traction motors and silicon rectifiers of Asea manu
facture. These two locomotives are included in a serie
of six prototype locomotives of type Rb, which are a
present being manufactured for the Swedish State Rail
ways. The other four locomotives will have tractio
motors of single-phase series type.

NEW ASEA BROCHURES

7601 E Lightning arresters types XBA and XBB. 16 pp.
7611 E EF 25 – a new contactor for 25 A, 500 V, 40–60 c/s. 2 pp.
7636 Ea Surge apparatus type TUA for testing the insulation in low-voltage installations. 2 pp.
7706 E Air-blast circuit-breaker for service voltages of 60–420 kV. 14 pp. (including supplement).
7729 E New Asea hoist. 2 pp.
7735 E Germanium and silicon rectifiers (reprint). 8 pp.
7737 E Driving equipment for rubber mills (reprint). 8 pp.
7738 E New compact geared motor. 6 pp.
7742 E Heavy-duty d.c. mill motors. 6 pp.
7745 E Position transmitters. 4 pp.
7746 Ea Asea arc furnaces and high-speed electro-hydraulic regulation (reference list). 5 pp.
7758 E Asea remotely-controlled valve-operating gear. 8 p
7763 E Large Asea furnaces for steelworks (reprint). 12 p
7766 E Asea mercury-arc rectifier. 2 pp.
7768 E Inhibited transformer oil. 4 pp.
7771 E Asea arc furnaces for foundries and steel industr 8 pp.
7776 E Asea and 400 kV. 12 pp.
7778 E Asea ground power converter set for servicing ai craft. 4 pp.
7781 E Active gap lightning arresters type XAL. 8 pp.
7790 E High-voltage d.c. power transmission (reprint 8 pp.
7793 E Loop regulation in rod and strip mills (reprint 4 pp.

CONDUCTORS AND CURRENT COLLECTORS

Eugen Törnros, Low-voltage Switchgear Design Department, Västerås

U.D.C. 621.874-831
621.315.172.047
Asea Reg. 6341

The article briefly describes Asea conductors and current collectors, particularly conductors of round copper wire, profile copper wire and T-sections of steel with rolled-on copper bars, insulators, conductor supports and conductor holders, rigid and sprung current collectors, sliding and rolling contacts and slip-ring devices.

The material and the equipment dealt with in this article is intended for use in crane installations having a maximum rated voltage of 500 V. Certain items can also be used in overhead cranes as well.

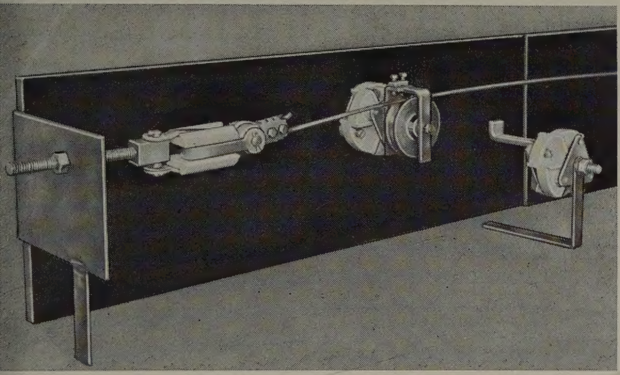


Fig. 1. Strain insulators with tensioning screw, roller, round wire inserted, wire support and rigid current collector with roller contact. (54614)

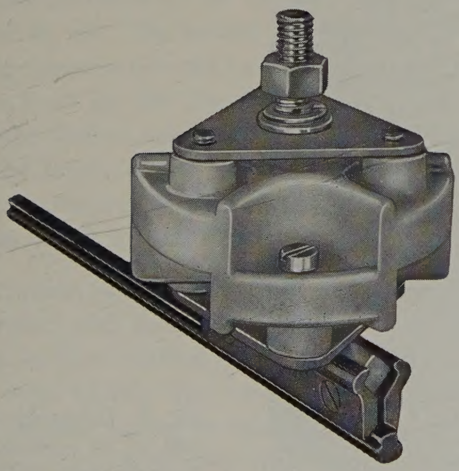


Fig. 2. Holder for profile copper wire. (50977)

Shielded contact rails have previously been described in Asea Journal 31(1958):4–5, pp. 54–56, and are therefore not dealt with in this article.

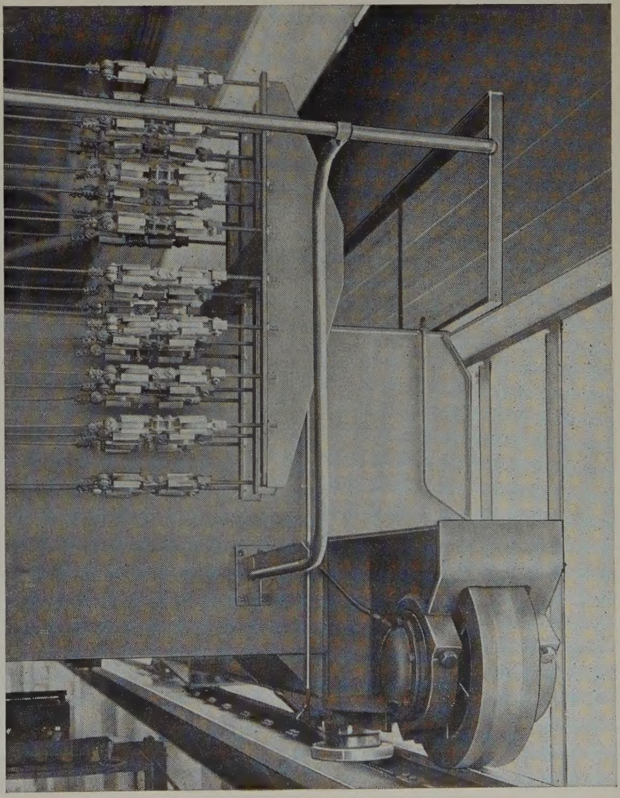
CONDUCTORS

Because both indoor and outdoor conductors are often located in a more or less polluted atmosphere, all the insulators are made of ceramic material. All are small, but have long creepage paths and high mechanical strength.

The more usual types of bare conductor are available in three different designs:

1. Conductor of round copper wire.
2. Conductor of profile copper wire in accordance with Swedish Standard SEN 21.
3. Conductor consisting of steel T-section with rolled-on copper contact bars.

Fig. 3. When single strain insulators cannot be used, for example, because of moist or salty air, two or more strain insulators can be connected together. (52981)



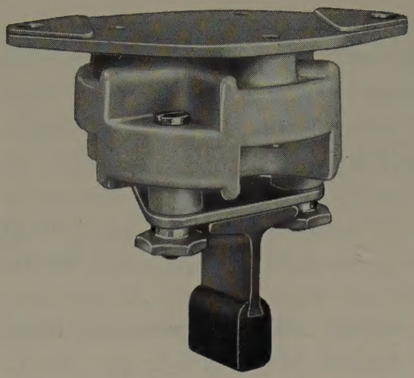


Fig. 4. Holder for a conductor consisting of a steel T-section with a rolled-on copper contact bar. (50858)

The choice of conductor type is influenced by various factors, for example, whether the conductor is to be erected indoors or out of doors, by atmospheric conditions, current loading, the length of the conductor and its method of suspension.

Round copper wire is the simplest design of conductor and is mainly used for the transverse conductors.

Where fairly short lengths of conductor are concerned, it is fastened with the aid of *strain insulators* at the ends, as shown in Fig. 1, and tension is applied by means of a bolt. The wire is fastened in a steel roller and a galvanised brass clamp. A similar clamp is used to link the supply cable with the wire.

Where the conductor is of any appreciable length, considerable slack, which varies with the temperature, may develop. The conductor must then be provided with *wire supports* which are placed along the conducto about 10–15 m apart. These wire supports must be s located in the vertical plane that the current collecto which guides the conductor and lifts the wire from th supports can freely pass over them. For this type c conductor, exclusive use is made of rigid current collectors of type LLVA, as shown in Fig. 1.

Round copper wire cannot be regarded as being safe i the case of outdoor installations if there are high wind particularly if the conductors are long.

Profile copper wire in accordance with Swedish Standar SEN 81 02 is used for longitudinal conductors and als for transverse ones with a wide span. Conductors c this kind are fixed at the ends and tension is applie to them in the same way as in the case of round wire However, the end of the wire is connected instead t a wire clamp by means of a steel wedge. The profil copper wire is carried in *wire holders* as shown in Fig. 2 which are spaced along the conductor at intervals o 4–6 m. This guides the conductor and, the shorter th distance between the wire holders, the greater th stability.

For this kind of wire, current collectors of rigid typ cannot be used, but, instead, various designs of spring loaded current collector have to be adopted.

The single strain insulator shown in Fig. 1 can be use in the case of indoor installations in relatively clean an dry air, or in outdoor installations where a protectiv roof has been arranged over the fixing device, an where the air does not contain salt. Where these con

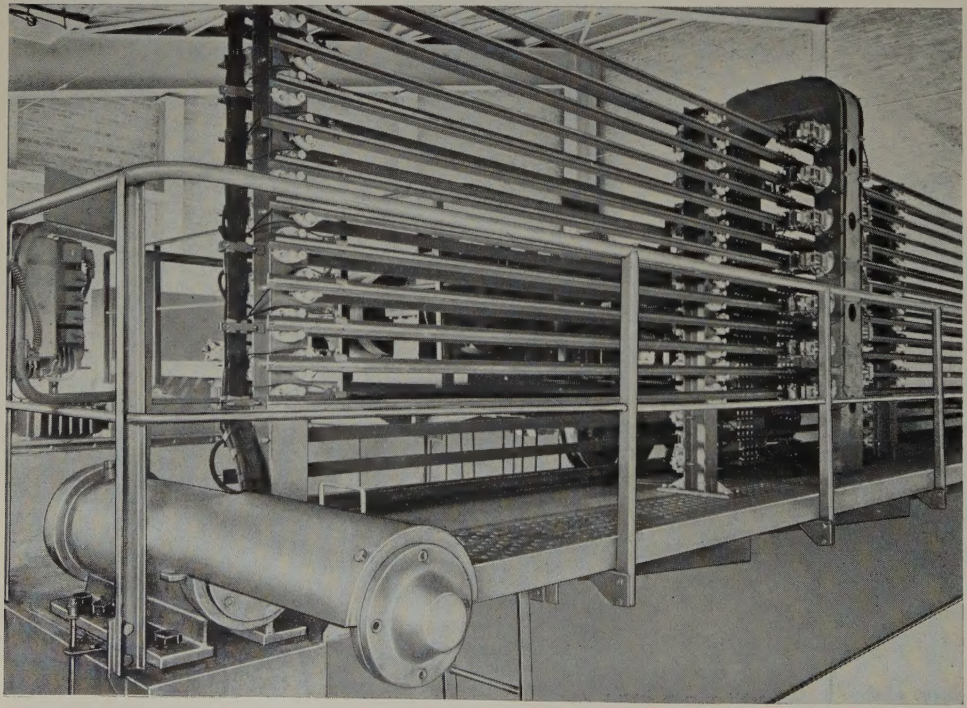
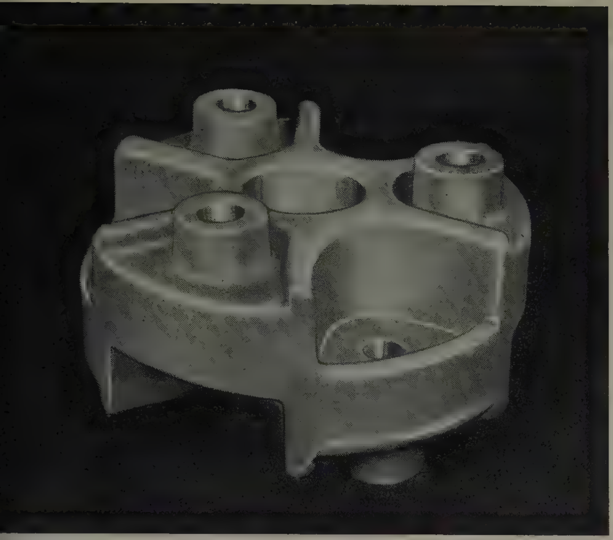


Fig. 5. Transverse conductors on an overhead cran mounted with holders an frames with spring-loade current collectors. (51788



ig. 6. The same insulator is used in the wire supports, wire olders, bar holders and current collectors (except current ollector type LLYC), thus simplifying replacement and the eeping of spares. (54503)

litions are not fulfilled, *two or more strain insulators* hould be connected one after the other, as shown in ig. 3.

n the case of the conductor designs described above, he current-collector contact slides or rolls along the ottom of the conductor. If the current collector is to e moved along the top of the conductor or along one f its sides, a certain rigidity of conductor is essential. In ases of this kind, the most suitable type of conductor s one consisting of a *steel T-section with a contact ar of copper* rolled on to it. This type of conductor is sed where high demands are made upon its mechanical trength, for example, in the case of high-speed cranes vith a high service intensity, or in the case of harbour ranes where the conductors often run in steel channels.

he conductor holders as shown in Fig. 4 fit those rofile bars available on the market which have a base vidth of 45 mm. The holders are so designed that, if he temperature varies, the bar can move longitudinally. Vhen it is set up, the T-section should be fastened in ne of the holders only, approximately about halfway long the length. Fig. 5 shows transverse conductor ars on an overhead crane, and the frame with current ollectors which is fixed to the crab.

Vire supports, wire holders and conductor-bar holders re provided with *insulators* as shown in Fig. 6. This nsulator is also included in all the current collectors xcept type LLYC. The insulator is fastened with rdinary screws, making its replacement and the keeping f spares a very simple procedure. The insulator fulfils he requirements of Insulation Class 8 in Swedish tandards SEN 28 01 and SEN 21 06. The flashover voltage during dry tests is 20 kV and the corona voltage during rain tests 5.4 kV.

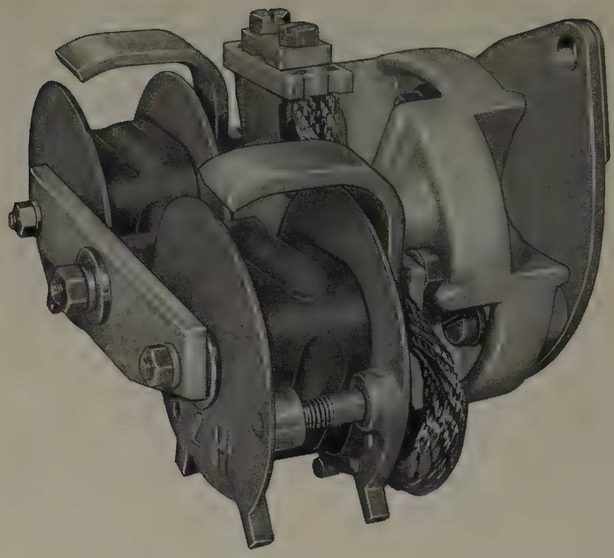


Fig. 7. A rigid current collector for 200 A with two sliding contacts. (43274)

On the strain insulator, the flashover voltage in the dry tests is 12.4 kV and the corona voltage in the rain tests 5.4 kV.

CURRENT COLLECTORS

The current collectors transfer current from the conductor to the electrical equipment of the crane.

Rigid current collectors are only used for conductors of round wire. The contact pressure is obtained in that the current collector lifts up the slack conductor.

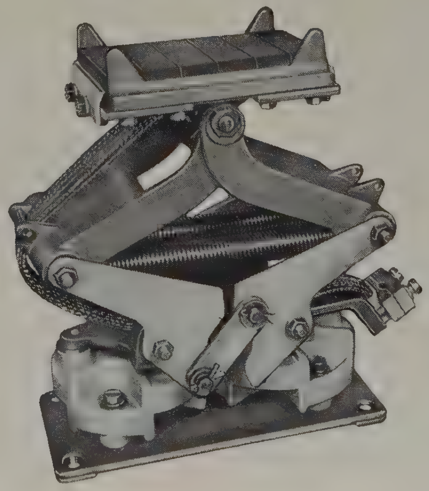


Fig. 8. Spring-loaded current collector of type LLXA of pantograph design with a sliding contact consisting of six electro-graphite carbon contact pieces and having a width of 80 mm. Range of movement ± 45 mm. (43282)

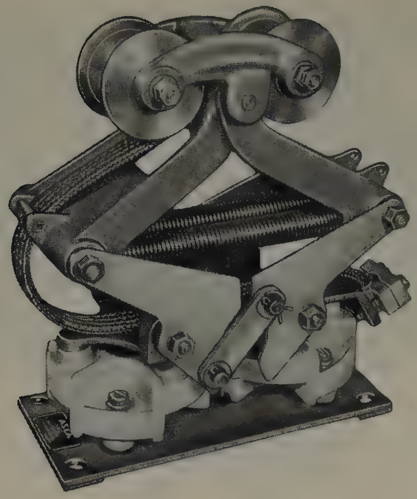


Fig. 9. Spring-loaded current collector of type LLXA of pantograph design with two roller contacts having a width of 38 mm. Range of movement ± 45 mm. (43281)

Spring-loaded current collectors must always be used for profile wire. The springing is necessary in order to provide correct contact pressure at all times, irrespective of the unavoidable variations in distance between the rail and the conductor. The current collectors must be provided with contacts which either roll or slide along the conductor.

Current collectors with roller contacts are provided with self-lubricating bearing bushes of graphite bronze which are uninfluenced by the temperature. The absence of lubricant facilitates the conduction of electricity by the bearing and reduces difficulties connected with maintenance and inspection. When roller contacts are used, an unavoidable result is that the actual contact surface with the conductor is very limited for which reason high load peaks may cause burning on the conductor and the contact roller.

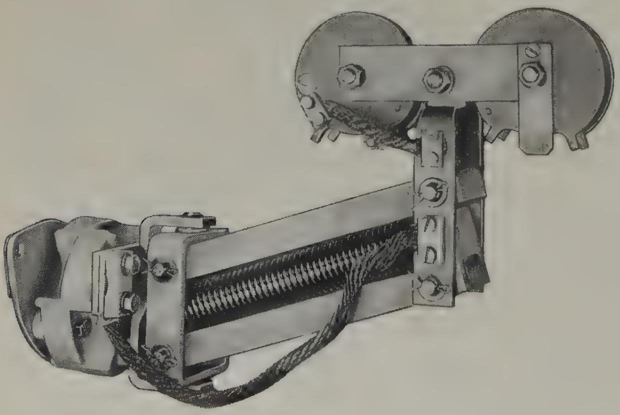


Fig. 10. Spring-loaded current collector of type LLYA with an arm of parallelogram design for a rated current of 200 A with two sliding contacts. Range of movement ± 35 mm. The arm will move laterally. (50974)

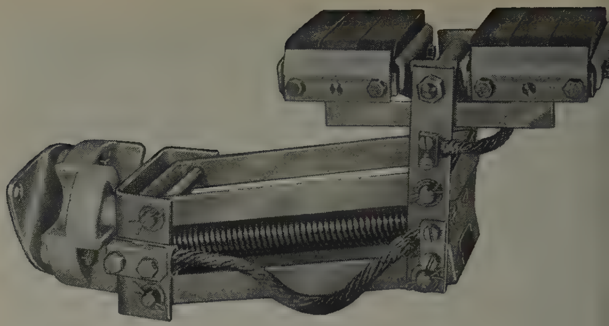


Fig. 11. Spring-loaded current collector of type LLYB wit an arm of parallelogram design for 200 A with two slidin contacts of electro-graphite carbon. Range of movement ± 3 mm. The arm will not move laterally and therefore th current collector can also be mounted on its side. (50976

Current collectors with sliding contacts have a contac surface which is designed according to the rated curren for which reason brief high load peaks do not normall cause damage to the conductor. The material of whic the contact is made is electro-graphite carbon. The cor ductor itself becomes highly polished, which reduces th risk of wear.

The sliding contact device is to be preferred in the cas of new installations. If, on the other hand, an instal lation which is already in use is to be provided wit new current collectors, these must be selected bearin in mind the type of current collector which was pre

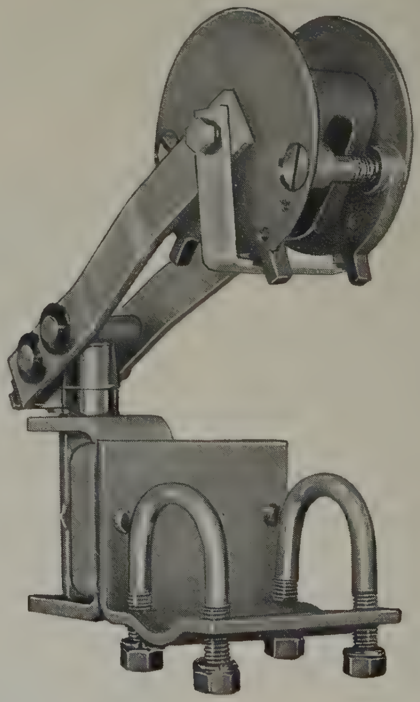
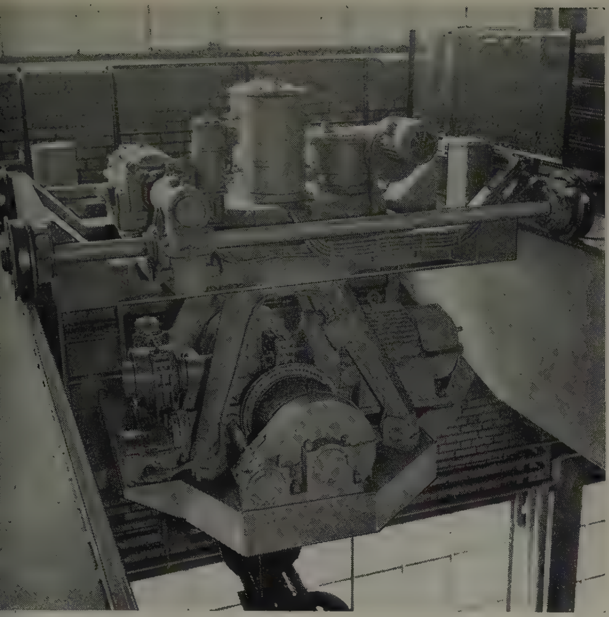


Fig. 12. Spring-loaded current collector of type LLYC f 60 A with a simple arm design which provides a range movement of ± 25 mm. The arm will move laterally and provided with a ceramic insulator. (50856)



ig. 13. Enclosed slip-ring device mounted on the crab of n overhead crane with slewing lifting machinery. (49642)

iously used with the conductor. Roller contacts and liding contacts should not be used on the same stretch f conductor since the surface of the conductor must e undamaged and smooth in order to ensure that the liding contacts are not subjected to unnecessary wear.

igid current collectors

hese have the type designation LLVA and are available n the following designs:

. With contact roller for rated currents of 100 and 200 A, as shown in Fig. 1.
. With a sliding contact for rated currents of 100 and 200 A, as shown in Fig. 7.

or a rated current of 200 A, use is made of two rollers, r two sliding contacts, which are arranged on an arm nd are so balanced that the pressure from the con- luctor is distributed equally between them.

he contact roller is made of copper alloy with self- ibricating bearing bushes and sliding contacts of electro- raphite carbon.

pring-loaded current collectors

urrent collector type LLXA is of pantograph design nd is intended for a rated current of 200 A. The cur- ent collector can be located beneath, above, or at the ide of, the conductor, the springs on the current col- ector being selected with reference to its placing. The ontact pressure is maintained practically constant over he permitted range of movement of ± 45 mm. The ontact rollers and all the joints have self-lubricating earing bushes of graphite bronze. Thus, no maintenance in the form of lubrication is required at the same time as the mobility of the joints is good and is unaffected by the temperature.

Fig. 8 shows a current collector of this type fitted with a sliding contact consisting of six electro-graphite carbon contact pieces and having a width of 80 mm. The current collector can also be designed with a contact width of 140 mm.

Fig. 9 shows a current collector which has two roller contacts with a width of 38 mm. A design with a roller width of 140 mm is also available. Current collectors with considerable contact width or roll width make, amongst other things, fewer demands on the accuracy of lateral position of the conductor, which may be of importance, for example, in the case of overhead cranes with conical wheels.

Current collectors of type LLXA have a wider range of movement and can be designed with larger contact widths than the arm-type current collectors described below. In addition, they have two insulators as against only one in the arm-type current collectors, thus offering the greatest possible reliability in service. Therefore, they are particularly suitable for use where running conditions are difficult.

Current collector type LLYA with an arm of parallelogram design can be obtained with one, or two, sliding contacts for a rated current of 100 or 200 A. Fig. 10 shows the design with two sliding contacts. The current collector can also be provided with rollers instead of sliding contacts, and, in both cases, these contact devices

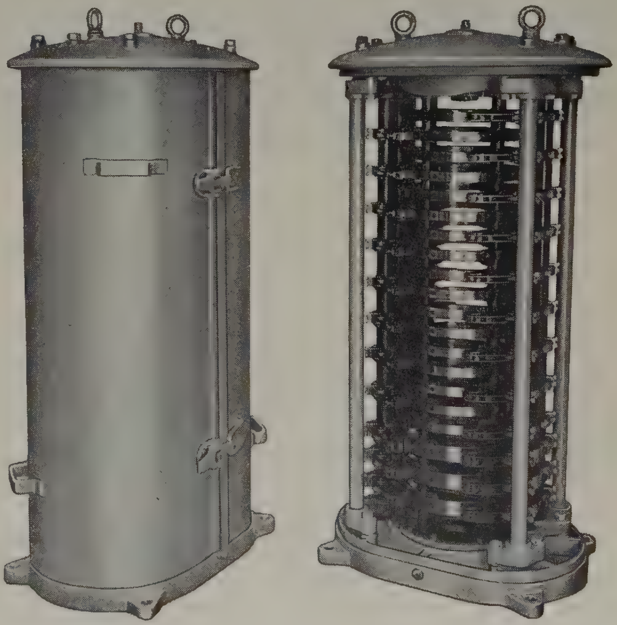


Fig. 14. Slip-ring device with three slip-rings for 300 A and 17 slip-rings for 100 A. The sheet-steel casing is split and can easily be removed after the four snap locks have been released. (35727)

are of the same design as for the rigid current collector type LLVA. The spring-actuated range of vertical movement is ± 35 mm. The arm will also move laterally so that variations in the distance to the contact line can be tolerated irrespective of the fact that the sliding contacts and rollers have a very limited width. This current collector is of a considerably cheaper and simpler design than the pantograph-type current collector of type LLXA. It cannot be mounted alongside the wire.

Current collector type LLYB has an arm construction similar to that of type LLYA, although it will not move laterally. This means that it is possible to mount the current collector on its side. Fig. 11 shows the design with two sliding contacts of electro-graphite carbon for a rated current of 200 A. Fig. 5 shows how the current collector is mounted on the cross-travel machinery of a large overhead crane.

Current collector type LLYC is intended for fairly small installations such as hoist tracks etc. In order to ensure that its dimensions are small, this type has been provided with a simple arm construction which allows of a range of vertical movement of ± 25 mm. The arm will also move laterally and is provided with a ceramic insulator, the dimensions of which are considerably smaller than on the other current-collector designs. The dry-test flashover voltage of the insulator is 13 kV and its rain-test corona voltage is 1.8 kV. Fig 12 shows a current collector of this type provided with a sliding contact of the same design as on current collector type LLYA and intended for a rated current of 60 A.

SLIP-RING DEVICES

For the transmission of current in the case of rotary movements, slip-ring devices are required in which the conductor consists of slip-rings against which sliding contacts, which are continuously in contact, serve as current collectors.

The slip-ring device type LLRA, as shown in Fig. 13, of particularly robust design and is hose-proof. Its m chanical connection with the central shaft-end of th crane is arranged in such a way that the oscillations the crane framework around the shaft-end do not cau any extra bearing pressure or stresses in the device. Th sheet-steel casing is split and can easily be remove after the four snap locks have been released, whereupo the slip-ring device is readily accessible for inspectio The slip-rings, which are made of copper and are split design, can have two different widths, a narrow one for a rated current of 100 A and a wider one f a rated current of 300 A. The sliding contacts are a ranged in pairs, one pair per slip-ring for a rated curre of 100 A and two pairs for a rated current of 300 They are fixed on insulated bolts in the frame of th device. The sliding contacts are made of copper carbo and do not need to be lubricated. Because of the absen of lubricant on the rings, there is always good curre transmission irrespective of the ambient temperatur Lubrication of the device is only required at the upp and lower bearings, and is carried out with the aid two external lubricating nipples.

The standard slip-ring device has three rings for a rate current of 300 A and up to 20 rings for a rated curren of 100 A. The height of the device varies according t the number of slip-rings. The diameter of the slip-ring is relatively large in order to provide room for connecting up the cables. The cable does not need to b provided with cable shoes, but can be fastened with clamp. Fig. 14 shows a slip-ring device with three ring for 300 A and 17 rings for 100 A, with, and withou its sheet-steel casing.

Open-type slip-ring device type LLRB is intended to b built into cable-reeling drums. The sliding contacts an slip-rings are of the same design as in the enclosed slip ring device for a rated current of 300 A.

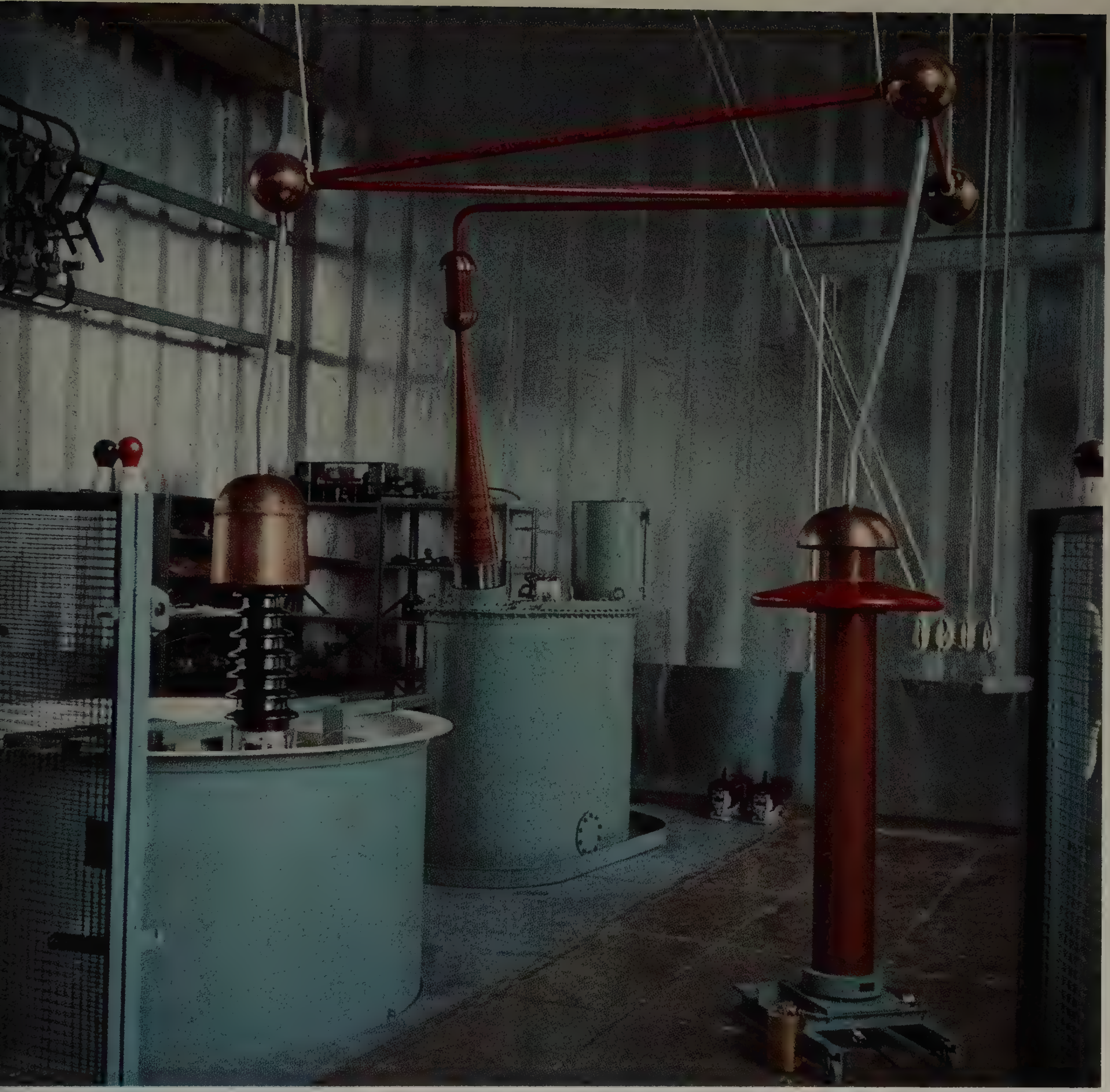
A SPECIAL ROOM FOR CORONA MEASUREMENTS

Björn Nyfors, High-voltage Laboratory, Ludvika

U.D.C. 621.3.015.532.001
Asea Reg. 0979

A short account is given of the principles of, and the equipment for, corona measurements and of the way in which these measurements are carried out. A special room at the Asea High-voltage Laboratory is described, where the test equipment and the screening have been arranged by simple means in order virtually to eliminate external disturbances.

When the premises of the Asea High-voltage Laborator at Ludvika were re-allocated it was possible to reserv a special room for measuring corona in high-voltag equipment. The initial conditions in this room wer decidedly unfavourable. The room is next to two high voltage test sites which work with high voltages, and in addition, a large number of power cables run in



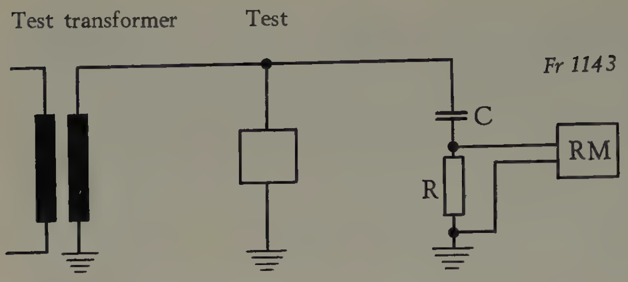
ig. 1. *Corona test room in the Asea High-voltage Laboratory t Ludvika. As a protection against external disturbances, the oom has been screened by means of copper foil on the floor nd aluminium foil on the walls and ceiling. (F 534)*

ulvert beneath the floor. However, it was decided to ttempt to improve matters by using inexpensive maerials and methods.

he alternative would have been to build a laboratory olely intended for measurements of this kind, situated a place which was relatively free from disturbance nd screened with the greatest care. However, as is hown below, the relatively simple measures which vere actually taken led to the achievement of a disurbance level which is completely acceptable for practil measurements and which is considerably better than hat which would have been obtained in ordinary unscreened premises exposed to normal "industrial" sources of disturbance.

THE MEASURING METHOD AND EQUIPMENT

If an insulating material is exposed to a sufficiently powerful electrical stress, partial discharges often occur before the puncture voltage is reached. The phenomenon, which is known as glow discharge or corona, gives rise to current impulses of short duration (up to several microseconds) and with great variations in both amplitude and frequency of repetition. Corona measurements, which imply the determination of the presence or absence of corona at a given voltage and the measuring of its intensity, give an idea of the stress to which the insulation in an electrical machine is exposed at this voltage.



C Disconnecting capacitor
RM Radio interference meter
R Measuring resistor

Fig 2. Test equipment for corona measurement in accordance with American Standards (NEMA Publ. 107).

At the High-voltage Laboratory, corona measurements of a more or less routine nature are mainly carried out in accordance with the proposed American Standard, NEMA Publ. 107, the test equipment consisting of a test transformer, blocking capacitor C, measuring resistor R and radio-interference meter RM (Fig. 2).

In this case, the disturbance impulses generated by the high-frequency "disturbance voltage" across the resistor R are measured with the aid of the radio interference meter (in principle a selective microvoltmeter) which is tuned to a given frequency (for example, 1 Mc/s).

The actual test equipment has been transferred from another smaller testing site and is, at present, designed for an r.m.s. value of 100 kV. In order to eliminate corona from the external circuit, the connections between the test transformer, test objects and blocking capacitor are made of copper tubing with a diameter of 42 mm (1.65 in.), copper spheres and flexible metal piping. At a later stage, the circuit will be redesigned for a higher voltage.

PROTECTION AGAINST EXTERNAL DISTURBANCES

The premises are about 6 m (20 ft) high, and the floor surface is 8.4 m × 16.4 m (28 ft × 54 ft). About half the floor space has been reserved for the corona test site (Fig. 1), which is also provided with an oil tank, 3 m (10 ft) deep and 2 m (6 ft 6 in.) in diameter, let into the floor. The rest of the space is used for other tests which call for freedom from disturbance.

Frequency Mc/s	Ratio between the disturbance signal inside, and outside, the test room	Damping dB
0,5	2,600	68
1	2,200	67
2	910	59
4	267	49
6	260	48
8	254	48
10	333	50
15	136	42
20	50	34
25	7	17

Table 1. Measurements of the disturbance level obtained inside, and outside, the screened test room.

The measures taken to screen the room were briefly a follows.

Copper foil with a thickness of 0.2 mm (0.008 in.) wa glued to the concrete floor and the joints were spot soldered together. In order to protect the foil, the floo was covered with linoleum. However, the test site itsel was provided with a floor of 1.5 mm (0.06 in.) bras sheet in order to facilitate earthing. The walls an ceiling were covered with paper to which aluminiur foil with a thickness of 9 μ was glued. The contact between the strips of foil was made secure by overlappin and the double folding of the one edge of the strip Because of the low mechanical strength of the foil, wainscot of aluminium sheet 1 m high was arrangec

The premises have two windows (2.8 m × 4.4 m 9 ft × 14 ft) facing an open yard. For the momen these have not been screened and this fact does no appear to have had any noteworthy influence on tests

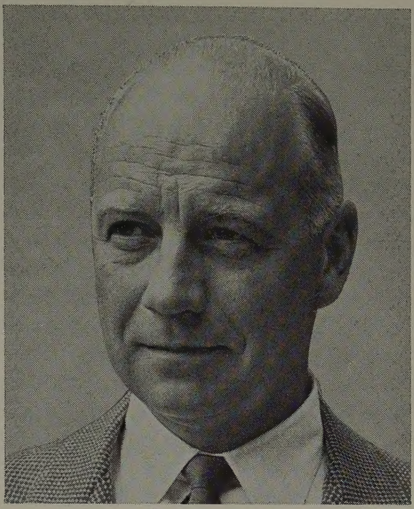
In order to obtain an idea of the effect of the screening the disturbance level inside, and outside, the test roor was measured by means of a radio interference mete with an aerial, at the same distance from another aeria which was fed with a signal of varying frequency. Th results can be seen in Table 1.

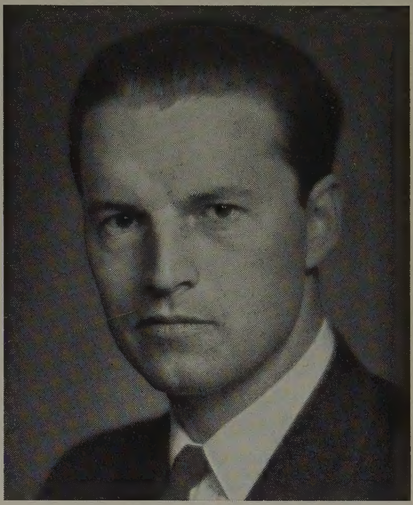
Thus, relatively effective screening has been obtaine at least at the lower frequencies. Since the routin measurements are mainly carried out at a frequency c 1 Mc/s, the screening is thus completely adequate fo these measurements.

REORGANISATION OF ASEA'S MANAGEMENT

he Board has decided that certain
ıanges are to be made in the struc-
ıre of the Management of Asea.
hey will come into effect as from
ıe Annual General Meeting to be
eld on April 28th, 1961, and entail
ıe introduction of a new post, that
f Chief Executive Director of the
sea Group, who will be resident in
tockholm. The Managing Director is
o concentrate on Central Asea mat-
ers, involving the activities of the
arent Company in Västerås, Lud-
ika, etc., where about 19,000 people
re employed (the Asea Group has
total of about 34,000 employees).
Ie will be resident in Västerås as
efore.

r Åke T Vrethem has been ap-
ointed Chief Executive Director of
he Asea Group as above, and con-
equently vacates his position as
Ianaging Director. The new Manag-
ng Director will be Mr Curt Nicolin,


Åke Vrethem


Curt Nicolin

who is now Managing Director of the de Laval Ljungström Turbine Company in Finspång.

Mr Nicolin, who was born in Stockholm in 1921, graduated from the Royal Institute of Technology, Stockholm, in 1945, and in the same year took up a post with Stal in Finspång, where he was put in charge of the Gas Turbine Department in 1950.

In 1953 he was appointed Deputy Managing Director and Technical Director. He became Managing Director in 1955 and remained in this position after the fusion with the de Laval Steam Turbine Company in 1959.

NEWS IN BRIEF

(Z 11828)

I.E.C. MEETING IN INDIA

A general meeting of the International Electrotechnical Commission (I.E.C.) took place in New Delhi, between October 30th and November 12th, 1960. Twenty-three technical committees and sub-committees held sessions at the meeting. The photograph alongside shows the Prime Minister of India, Mr Nehru, conversing with the President of the I.E.C., Dr I. Herlitz, from Asea, Sweden.

Dr Herlitz, in his capacity as Chairman of the Swedish Electrotechnical Commission, has participated in I.E.C. activities since 1947 and was elected President for the three-year period 1958–61 in the course of the I.E.C. meeting in Stockholm in 1958. Asea Reg. 9759

ELECTRIC THREE-COACH SETS FOR SUBURBAN LINES

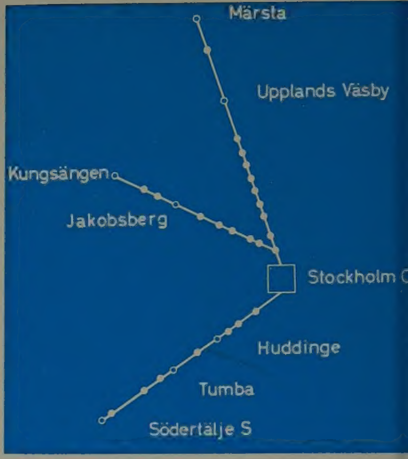
Suburban railway traffic in Greater Stockholm is at present in the hands of the Stockholm Passenger Transport Company, the Swedish State Railways, the Lidingö Railway and the Saltsjö Railway.

From the time of the electrification of the Saltsjö Railway in 1912, Asea have been major suppliers of suburban electric motor coaches, both for the Swedish State Railways and local transport companies. In Stockholm itself, until recently, deliveries have been confined to the Stockholm Passenger Transport Company and other local companies. Thus, Asea have supplied the Stockholm Passenger Transport Company with electrical equipment for about 450 underground coaches and have equipment on order for a further 150 making a combined total of 600 coaches. However, Asea have supplied motor coaches or multiple-unit trains on a large scale to the railway authorities for use in suburban traffic around Gothenburg, Malmö, Borås and several other Swedish towns. Asea have also supplied multiple-unit sets for the highly developed suburban railway network around Warsaw.

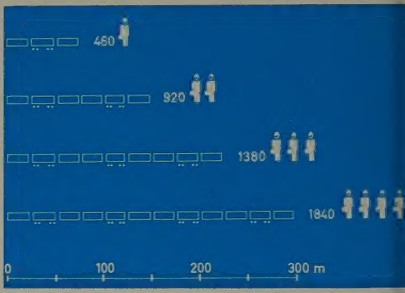
Hitherto, the Swedish State Railways have used locomotive-hauled trains for their share of the suburban railway traffic in the Stockholm area. However, several years ago, a traffic commission showed that this part of the Stockholm suburban traffic should, for preference, be carried in motor-coach trains made up in three-coach sets which can be combined into multiple-unit trains consisting of six, nine, or twelve coaches. In the middle of 1956, Asea received an order for three sets of this kind which were given the designation Xoa6, and which were delivered in the spring of 1960. At the moment, they are to be regarded as prototypes, but if the tests prove to be satisfactory, a considerably larger series, probably between 30 and 40 sets of this kind will be ordered.

The suburban traffic in Stockholm run by the Swedish State Railways has hitherto used the Stockholm Central Station as the terminus for the three radial lines running in the direction of Uppsala, Västerås and Södertälje. Now that the Swedish State Railways have decided to electrify the Nynäshamn line, a fourth route will come into the picture. When, at some time in the future, the suburban railway traffic of the Swedish State Railways is handled entirely by motor-coach sets, the object is for the trains to be run, for example, directly from Södertälje to Upplands-Väsby etc., thus making the Stockholm Central Station an intermediate one on this line. Naturally, this change will not affect other railway traffic to and from Stockholm.

The three-coach sets now supplied have been run experimentally during the greater part of 1960, and, as a result, certain modifications have been adopted. The electrical equipment has proved, however, to work quite satisfactorily and will not be subject to any alterations. The riding qualities of the coaches have been extremely good from the very beginning, for which reason the bogies can be used virtually without alteration in the coming series, while the design of the body will be somewhat modified to provide a lighter construction. Further the coaches have been deliberately designed with different tests in mind; thus, for example, there are both sliding doors and folding doors. Various methods of train heating are also being tried out. The experience gained during the present experimental service will be used as a basis for deciding the final design.



The Swedish State Railways' suburba lines around Stockholm. (Z 11650)



The length of train and number of passengers in suburban trains consisting c 1–4 three-coach sets. (Z 11651)

For all suburban traffic it is axiomatic that the station stops should be as short as possible, that the rate of acceleration and retardation should be high and that the coaches should be planned with the greatest possible reserves of space in order to be able to deal with rush-hour traffic. A fully loaded three-coach set will take 460 persons, of whom 310 will have sitting accommodation. Thus, if four sets of this kind ar combined to form a twelve-coach trair 1,840 persons can be carried in a trai about 300 m long. Since the series c coaches to be manufactured will deviat somewhat from the present prototypes as far as the design of the body is concerned, a complete description cannot b given until the final design has bee decided upon.

In addition to what has been state above, the following can also be said. I a three-coach set there are four tractio motors with a combined rating of 1,50 h.p. Thus, a twelve-coach train will hav an installed motor output of 6,000 h.p The maximum speed is at present 10

A suburban train consisting of one three-coach set. (55547) n/h (63 m.p.h.), but will probably be creased to 120 km/h (75 m.p.h.).

he major part of the electrical equip- ent has been located beneath the floor f the central motor coach in each set and omprises, in addition to auxiliary ma- inery, a transformer with contactor quipment for low-voltage regulation in) steps. The coaches have modern disc rakes and, in addition, the motor coach is provided with rheostatic electric braking. The braking resistors are located on the roof.

The coaches are heated by means of warm air which is blown in at the roof, beneath the windows and under the seats, the temperature being controlled by means of thermostats.

The automatic couplings between the three-coach sets ensure that the composition of the train can rapidly be changed as necessary.

Asea are the main contractors and have supplied the electrical equipment and designed the bogies. The other mechanical equipment was designed and supplied by AB Svenska Järnvägsverkstäderna at Arlöv (the end coaches) and Kockums Mekaniska Verkstad at Malmö (the central motor coaches). Asea Reg. 6132

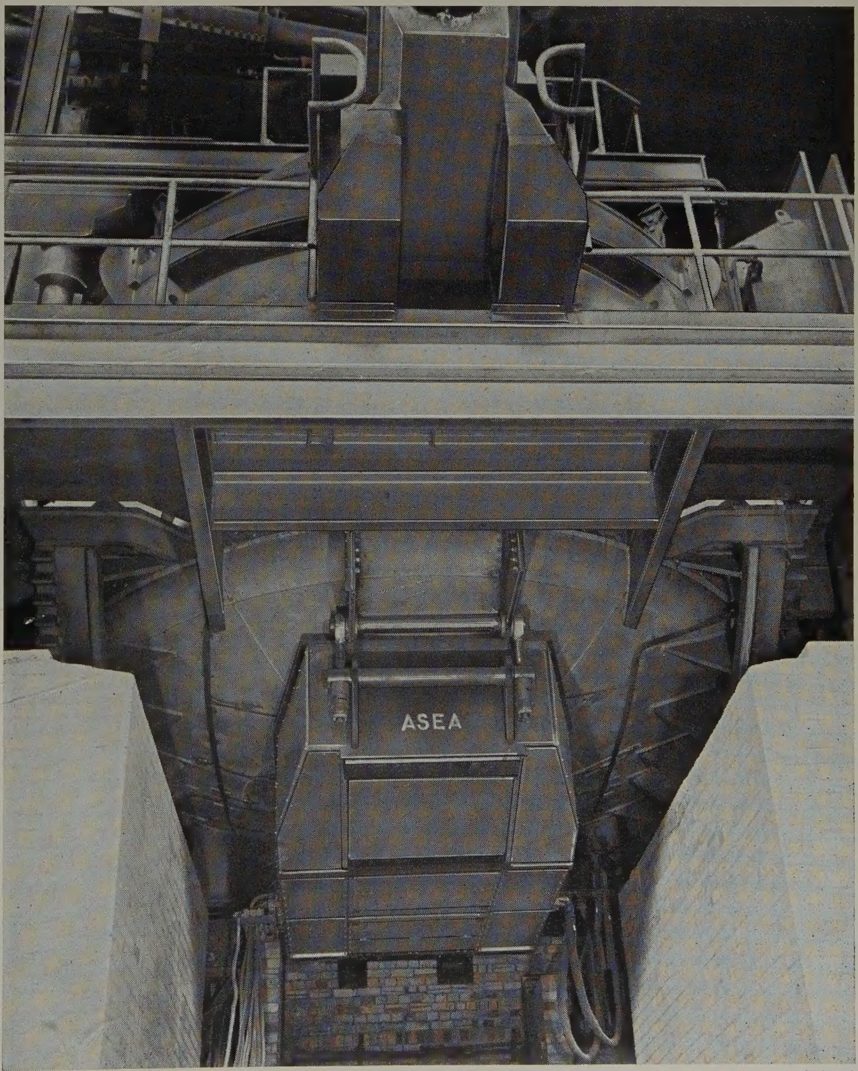
NDUCTION STIRRER AT SAMUEL OX & CO.

fter Samuel Fox & Co. Ltd., Sheffield, ne of the best-known steelworks in ngland, had gained experience with their rst Asea induction stirrer, they purchas- d the second one which was taken into ervice in the summer of 1959 for a 80- on arc furnace with a bath diameter of m. The new stirrer is supplied with low- requency current from the same con- erter equipment as the first induction tirrer, which was installed at the steel- vorks in 1955 beneath the 60-ton furnace vith a bath diameter of 5.8 m. With the id of contactors, the furnace personnel an either run the one stirrer or the ther, or both at the same time. Natu- lly, in the latter case, the stirring power somewhat reduced, but is, however, dequate for the time-consuming reduc- on period when maximum mixing is not ecessary.

he correct voltage, current and frequency or the various types of service is set utomatically with the aid of auxiliary ontacts. The rating of the older induc- on stirrer is 460 kVA, 225 V, 1,020 A, .6 c/s, two-phase, and of the new one, 50 kVA, 130 V, 1,350 A, 0.6 c/s, two- hase, and the rating of the converter is × 350 kVA, 260 V, 1,350 A, 0.35–0.7 c/s, wo-phase.

hese two arc furnaces are used, amongst ther things, for making low-alloy quality eel. As long as the first furnace alone as equipped with an induction stirrer, was found that it made possible con- derably better control of the steel manu- cture than did the furnace which was uilt some years later but which, to egin with, was not provided with a irrer. This better control depended on e more even conditions which the stir- er gives in the bath, with considerably etter homogenisation and equalisation f temperature as a result. A comparison owed clearly that an induction stirrer is a necessary investment when manufacturing two-slag steel, and that it provides a good economic yield.

The Asea induction stirrer has also proved itself to be extremely useful when slagging. All the remains of the oxidised slag are moved by the stirrer towards the slagging door, which ensures effective slagging and a low phosphorous content in the steel. Naturally, this is particularly important in large furnaces. Previously, it was not possible, in spite of considerably heavier work, to reach such low and even values. Asea Reg. 663



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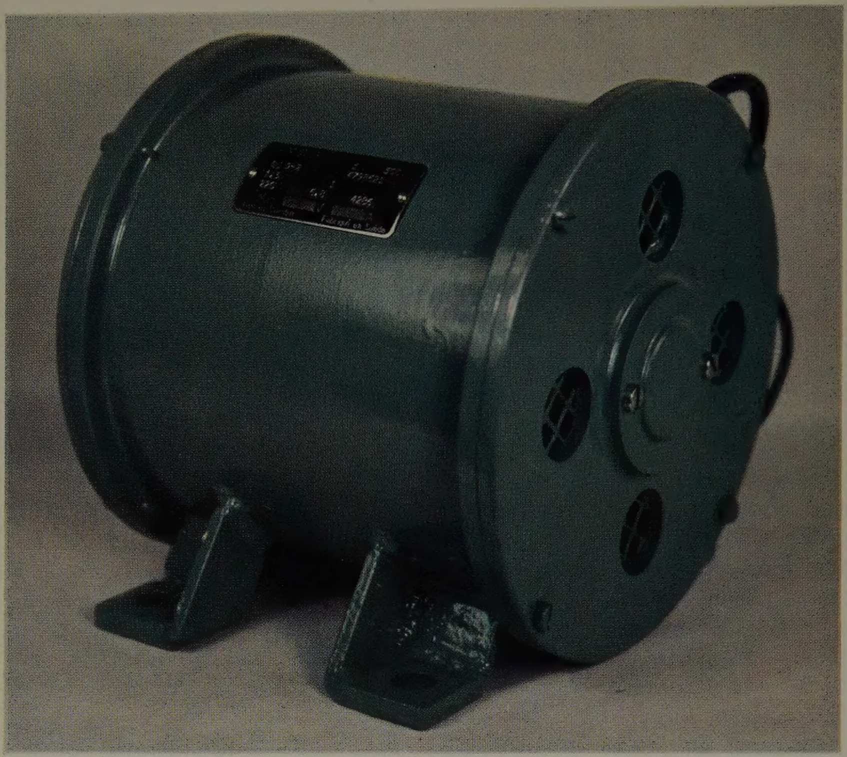
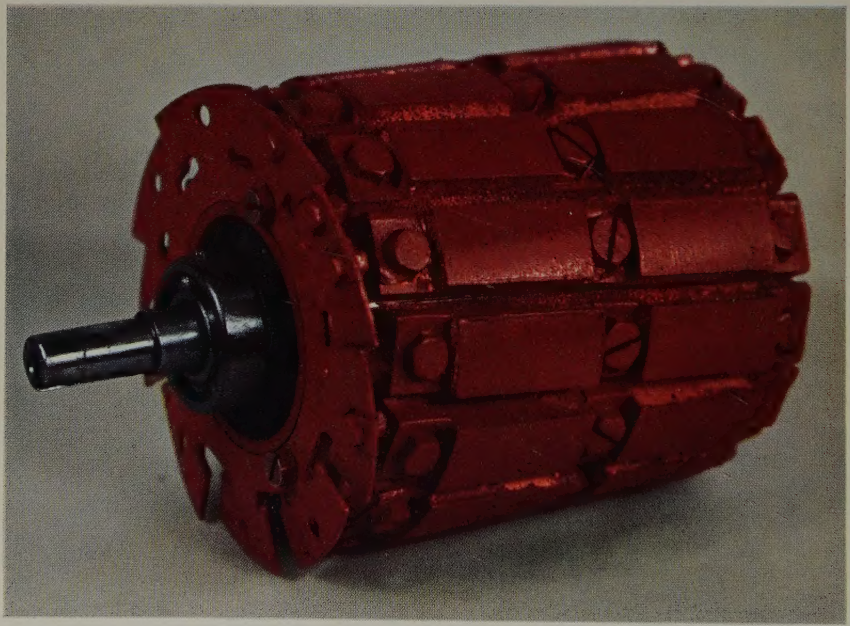


(F 269)

AN A.C. GENERATOR WITH PERMANENT MAGNETS

The illustrations show a small single-phase generator rated at 1.5 kVA, 4,286 r/m, 500 c/s, 220 V, with permanent magnets in the rotor. The generator has been supplied to the Norwegian Institute of Technology, Trondheim. In order to make the machine as small as possible, the magnets were made of anisotropic (oriented) material, of Surahammar quality 500 A. The list values for this magnetic material are: remanence $B_r = 1.18$ T (11,800 gausses), coercive force $H_c = 52{,}000$ A/m (660 oersteds) and the maximum value for the product of B and H, $(BH)_{max} = 40{,}000$ T A/m (5×10^6 G Oe).

Asea Reg 4429



(F 270)

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